Domestic Water Consumption on an Upper Middle Class Community in Curitiba, Brazil

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Abstract

The actual patterns of consumption have influenced and changed the way of water consumption. As water consumption is an important parameter of water resources management, it is necessary to understand how the familiar basis is organized and how it modifies this consumption. This study investigates how the domestic water consumption is influenced by the presence of children, maids, pets and others, during one year and a half. The water consumption data were compared based on the information about characteristics of the occupants of housing units, such as gender and presence of pets or employees. The history of water measurements and an occupation profile of dwellings of an upper middle-class residential condominium were analyzed in the municiaplity of Curitiba, Paraná State, Brazil. The results showed that only children and pets impact significantly the water consumption. It was also observed that single men consumes less water than single women or couples.

Keywords

Water; Consumption; Water Demand; Water Management; Upper Middle-Class

Introduction

Credible long-term forecasts of water demand are essential to all types of water planning. Without such forecasts, water managers cannot achieve an efficient allocation of water supplies among competing uses or ensure their long-term sustainability (Dziegielewski & Baumann, 2011). The way people use water in their everyday life may change their social and economic conditions.

The contemporary society has significantly changed lately and, nowadays, it is common to find people living alone or with dogs or cats. Will this new family arrangement influence water consumption? The answer to this question may contribute to the water management.

Schleich & Hillenbrand (2009) stated that residential water consumption in Germany has changed substantially over the last two decades, decreasing from 200 L per day in 1970 to 126 L per day in 2004, but water use in newer states was only 93 L compared to 132 L in other states. They also reported that average daily per capita consumption of water in EU-15 countries ranges from 115 L in Belgium to 265 L in Spain. Nasrabadi et al. (2013) verified that over 70% of the consumers are families in a study conducted in Tehran.

Considering the amplitude of the water use pointed out by Schleich & Hillenbrand (2009), it may be inferred that water consumption may be different in each period of time and space. Thus, it is important to determine the per capita consumption in each water supply system as well to investigate how people living in apartments or houses have different water consumption.

Carragher et al. (2012) reviewed the water consumption indexes and described case studies whose results for average water consumption in an indoor situation varied from 150 to 169 L/person.day in Australia and from 262 to 291 L/person.day in the USA/Canada.

However, Evarts & Swan (2013), investigating the hot water consumption in Canada, concluded that the domestic hot water use standard of 60 L per capita day is sufficient for large households, but didn´t capture increased use of domestic hot water in smaller households. These results are sensibly higher than the obtained by Nnaji et al. (2013) of 34.9 L/person.day in Nsukka Metropolis, in Nigeria.

On the other hand, the hot water consumption is also variable. Bøhm (2013), analyzing Danish apartment buildings and institutions, showed that the hot water consumption may vary from 1.28 to 4.34m³/ month/ apartment.

In Brazil, Ghisi & Ferreira (2007) obtained an average consumption of 151.3 L/person.day in a four-storey residential building composed of three blocks built in 1981 in the city of Florianopolis, in the South region of Brazil.

The objective of this study was to investigate how the characteristics of consumers in terms of family formation influencing the water consumption. Do pets, children or domestic employee lead to less sustainable water use? Do men consume less water than women? These are some of the questions that can be answered in this work.

Materials and Methods

The method consisted of the comparison of hot and cold water consumption by the occupants of housing units through the collection of recorded measurements by the water meter. Essentially, there are two kinds of data acquisition in the study collected through interviews and measurement of water consumption by individual water meters.

The data of hot and cold water consumption measured separately by water meters were processed and compiled by a spreadsheet program (Microsoft Excel). The results of water consumption include only the consumption within the apartments, excluding consumption in external areas.

Study Area

In order to investigate the domestic water consumption in Brazilian upper middle class, a residential condominium built in 2009 in the city of Curitiba, State of Parana, Brazil, was chosen.

Curitiba, the capital of the state of Paraná, located in the southern part of Brazil is also the heart of a metropolitan region formed by twenty-six municipalities and over 3.1 million inhabitants. The city's 1.8 million inhabitants are settled down in an area of 430 km² divided into nine administrative regions, encompassing seventy-five neighborhoods. Curitiba became, in 2010, the eighth most populous city in Brazil (Miranda et al., 2012).

In urban planning in Curitiba, practices are based on the principle that the use of land in the city may be induced, restricted and organized. Once the zoning is defined by general use, for each region, certain parameters must be considered to allow the city development in a sustainable manner. However, the urban climate is one aspect which so far has not been sufficiently considered by urban planners (Givoni &

Kruger, 2007).

The climate of Curitiba (25º 31' S, 917 m elevation) varies considerably with tempertures ranging from 12 to 14°C (53.6 to 57.2 °F) in winter and from 17 to 20°C (62.6 to 68 °F) in summer. Annual average temperature is about 16ºC (60.8 °F). Daily amplitudes vary between 0.5 and 25.7K, and the average swing is 10.5K. Absolute humidity ranges from 4 to 18 g/kg, with an average of 11 g/kg. Annual precipitation is around 1600 mm. According to Köppen climate classification, the climate is considered to be mesothermic, humid subtropical (Cfa) (Kruger & Givoni, 2007).

The condominium object of this study consisted of two towers, with a total of sixty three apartments. Each apartment has three bedrooms, two bathrooms, a sitting room, a kitchen and a laundry. The total area of each apartment was around 150 m², including two spots in the parking lot. The total useful floor area was around 100 m².

During a period of a year and a half, the number of residents in each apartment was computed, including pets and domestic employees. The water consumption, either cold or hot, was registered by water meters. The data acquisition was done from January 2011 to May 2012. A characterization of community by gender and age group of the interviewed, domestic employees and pets is shown in Table 1.

TABLE 1 GENERAL CHARACTERISTICS OF THE ANALYZED COMMUNITY

Characteristic	Total Number (units)
Residential units	63
Adult men	52
Adult women	60
Children	20
Domestic employees (dairy or once a week)	40
Pets (dogs or cats)	22

Results and Discussion

The results include the actual data obtained through a questionnaire and the measurements done directly on the water meters throughout the analysis period. The demographic profile was obtained through a proper form, delivered to each resident/apartment. The results of this collection are are shown in Table 2.

Results indicated that 132 people live in the sixty-three apartments, apart from domestic employees and obviously pets, which represented an average of 2.1 people by residential unit. Out of the 132 people, 52 (39.4%) were men, 60 (45.5%) were women and 20 (15.2%) were children. In total, there were 22 pets (dogs or cats), 8 domestic employees that worked

every day at the same apartment (one employee/ apartment) and 32 domestic employees that work once a week.

TABLE 2 DEMOGRAPHIC PROFILE

Habit Index	Adult men	Adult women	Children	Pets	Maid	Total Pop.
1	1	1	0	0	1	3
2	0	1	0	2	1	2
3	1	1	1	0	1	3
4	0	1	0	0	1	2
5	1	1	0	2	1	3
6	1	1	0	0	0	2
7	1	1	0	0	1	3
8	1	1	0	1	0	2
9	1	1	1	1	1	4
10	1	1	0	1	1	3
11	1	1	1	0	1	4
12	0	1	0	0	0	1
13	1	1	0	0	0	2
14	1	1	0	0	1	3
15	1	1	0	2	1	3
16	0	0	0	0	0	0
17	0	1	0	0	0	1
18	1	1	0	0	1	3
19	1	1	1	0	1	4
20	1	1	0	0	1	3
21	1	1	0	0	0	2
22	0	1	0	0	1	2
23	1	1	0	0	1	3
24	1	1	1	0	1	4
25	1	2	0	0	0	0
26	1	1	1	1	1	4
27	1	1	1	1	0	3
28	1	1	1	0	0	3
29	1	1	0	0	1	3
30	1	1	0	2	1	3
31	1	1	0	0	1	3
32	1	1	0	0	1	3
33	1	1	1	1	1	4
34	0	2	0	0	0	2
35	1	1	1	1	1	4
36	1	1	0	1	0	2
37	1	1	0	1	1	3
38	1	1	2	1	0	3
39	1	1	0	1	0	2
40	1	1	0	1	1	3
41	2	1	0	1	1	4
42	0	0	0	0	0	0
43	1	1	0	0	0	2
44	0	1	1	0	0	2
45	1	1	0	1	1	3
46	1	1	0	0	1	3
47	1	1	2	0	0	4
48	1	1	0	0	1	3
49	1	1	0	0	1	3
50	1	1	0	0	1	3
51	0	2	0	0	0	0
52	1	0	0	0	1	2
53	1	1	0	0	1	3
54	1	1	2	0	0	4

Habit Index	Adult men	Adult women	Children	Pets	Maid	Total Pop.
55	1	1	1	0	1	4
56	1	0	0	0	0	1
57	0	0	0	0	0	0
58	1	1	0	0	1	3
59	0	1	0	0	0	0
60	1	1	0	0	1	3
61	1	0	0	0	1	3
62	1	1	0	0	0	2
63	1	1	2	0	1	5
Total	52	60	20	22	40	164

The average water consumption was 12.6±5.6m³/ month/residential unit, being the average consumption of 6.4 ± 3.3 m³/month/residential unit to cold water and 6.2 ± 3.0 m³/month/residential unit to hot water, meaning that the average water consumption was 5.9 m³/person/month or 198 L/person/day. The average consumption measured by the municipality was smaller, of 138 L/person/day. This difference was attributed to the economic condition, because this study was done considering an upper middle class community.

These results showed that, for a family of upper middle class Brazilian, the consumption of cold water may be greater than that found by Bøhm (2013), whose results vary between 1.4 and 4.3 m³/month/ apartment of buildings for Danes .

For homes with pets, like dogs and cats, it was verified that the presence of pets has increased significantly (until 23% on average) the water consumption. For 45 homes without pets, the average consumption was 5.8 m³/person/month against 6.4 m³/person/month in units (14) with only one pet and 7.5 m³/person/month in homes with two pets.

The influence of children on water consumption was also evaluated. Residential units with no children (46) had a per capita average of 6.4 m³/month while those with one child (14) had 5.6 m³/month and those with two children had 5.0 m³/month.

By comparing water consumption between men and women, it is possible to conclude that the water consumption of single men is at least 25% less than single women or couples. The per capita water consumption for single men was 5.0 m³/month, for single women that was 6.6 m³/month and for couples 6.0 m³/month. It was also verified that single men used proportionally more hot water than single women or couples, around 60% of hot water consumption. On the other hand, women or couples consume around 49% of the total consume with hot water.

The attendance of diary domestic employees did not

significantly affect (only 3%) the water consumption.

Eight residential units with domestic employees every day had the water consumption of 6.2 m³/per capita/month against 6.0 m³/per capita/month of those without domestic employees. To the apartments with domestic employees once for a week, this gap was only 1% (6.0 against 6.1 m³ of water/per capita/month).

Considering that the study has been carried out in the south hemisphere, i.e., in which the warmer months are from October to March and the colder months are from May to September, it can be seen from Figure 1 that the peaks on hot water consumption occur in the colder months. The gap between the highest and lowest levels of hot water consumption was lesser than 43%. Concerning the cold water consumption, this gap was around 58%. The difference between the average consumption of hot and cold water was insignificant (2.86 against 2.77 m³/per capita/month).
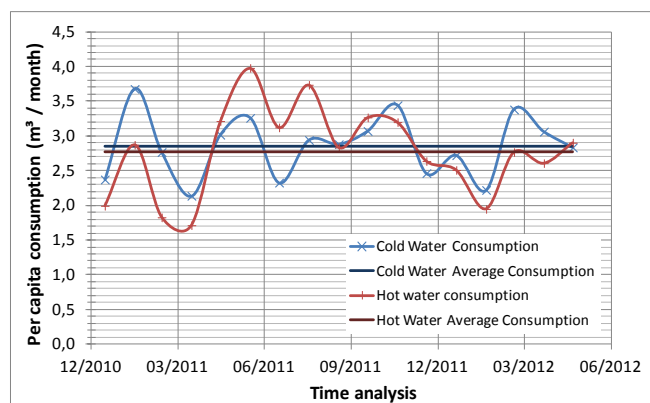

FIGURE 1 WATER CONSUMPTION VARIATION

Conclusions

In this study, it was confirmed that the water consumption of Brazilian upper middle class was influenced by family composition. A South Brazilian upper middle-class citizen in the analyzed community consumes an average of 198 liters of water per day. Furthermore, residential units with animals have increased in 23% the water consumption in comparison with the units without pets. The study showed that children use less water than adults (around 22%). The results also indicated that single men consumed less water (until 25%) than single women or couples. In terms of the use of external workers, the research revealed that their presence did not significantly affect the water consumption (only 1 to 3%). Another conclusion, in agreement with common sense, is that the consumption of hot water is higher during the winter than summer, mainly on residential units occupied by single men.

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